ISSN 2599-8293

European Commission

CORDIS Results Pack on

digitalisation of the energy system

A thematic collection of innovative EU-funded research results

September 2022

Research and Innovation

Contents

Editorial

Digital technologies have advanced more rapidly than any innovation in our history. Today, data-driven technologies dominate the way we live, learn, travel, and interact with each other. Now, it's time for our energy system to follow suit and embrace the benefits of digitalisation. Published to accompany the European Commission's action plan to support digitalisation of the energy sector, this CORDIS Results Pack explores how EU-funded research projects are paving the way for digital solutions to build a more secure and diversified energy supply, all while improving efficiency and resilience, reducing emissions and providing citizens with innovative energy services.

The goal of becoming the world's first climate-neutral continent and the announcement that the 2020s will be the digital decade are two of the European Commission's ambitious priorities for the coming years. To reach the first goal, we need to accelerate the clean energy transition by speeding up the switch to renewables and hydrogen. We also need to become more energy efficient and reduce our dependency on imports. This ambition is reflected in the March 2022 Joint European Action for more affordable, secure and sustainable energy, REPowerEU.

Combining the green and digital energy transitions

The digital transformation helps decarbonise our energy supply, addressing our reliance on fossil fuels and promoting the uptake and integration of renewables in our energy system, while increasing its resilience. At the same time, digitalisation will generate jobs, open new opportunities for European businesses and encourage the development of secure technology. Finally, it provides tools that enable citizens, prosumers and communities to play an active role in the energy market.

This digitalisation is already under way, with many EU policies targeting specific areas of innovation, such as provisions for efficient and secure data exchange, as well as measures for the deployment of smart meters.

Building on existing policies, the European Commission's action plan will lay the groundwork for building an integrated energy system that can support the growing interconnectedness of the market and enable digital and energy value chains to work more closely together. This CORDIS Results Pack explores the results of EU-funded research projects that address five areas that are key for energy and digitalisation.

EU research in 5 key areas of focus

Area 1: Developing a European data-sharing infrastructure for new energy services. The INTERRFACE, CoordiNet, Sharing Cities and INTERCONNECT projects support the development of a European digital data infrastructure to facilitate data exchange both at appliance level as well as among different players along the entire energy value chain.

Area 2: Empowering citizens by developing tools to support their participation in the energy market. This means designing a data-driven energy services market that has consumers' benefits and rights at its core, and developing and implementing reskilling and upskilling pathways and 'digital energy literacy'. The DRIMPAC and COMPILE projects both focus on the citizen's role in the digitalised energy market.

Area 3: Enhancing the uptake of digital technologies in the energy sector, and promoting the market uptake of investments in research and innovation. The ROMEO project has developed a solution for structural health monitoring of wind turbines using big data, machine learning and cloud-based analytics, while EdgeFLEX is working on an advanced energy aggregator for virtual power plants.

Area 4: Enhancing the cybersecurity of the energy sector to meet real-time requirements. The SerIoT project delivered an intelligent solution to ensure IoT networks safely continue business as usual regardless of network conditions; EnergyShield developed a toolkit to support electrical power and energy system operators in the fight against sophisticated cyberattacks and data breaches.

Area 5: Promoting climate neutrality actions for the IT sector. This includes prioritising energy-efficient solutions and the use of renewables in all stages of the digital value chain, while supporting the deployment of sustainable products and services. The BodenTypeDC project built a data centre to address the need for innovative and more energy-efficient solutions in the data centres industry.

Powering the transition to a distributed, smart grid

The digital revolution in the energy sector is sparking hope for securing a more sustainable future. INTERRFACE is designing a common architecture with standardised products and processes that joins power system operators and customers, allowing seamless, transparent exchange of energy services across the power system.

With the network codes drafted by the European Network of Transmission System Operators for Electricity (ENTSO-E) and the Clean energy for all Europeans package, the EU has set the energy transformation in motion.

The measures encourage service procurement at both the transmission and distribution levels, thereby enabling more effective network management, increasing the level of demand response and growing the renewable generation capacity. Transmission and distribution network operators are now called on to define and coordinate the procurement services in collaboration with active market users.

"Digitalisation facilitates the coordination and active system management in the electricity grid, enabling transmission and distribution network operators to optimise the use of distributed resources and ensure a cost-effective and reliable electricity flow. What's more, end users can become active market participants, for example by selling self-generated electricity or balancing energy demand," says Georgios Boultadakis, coordinator of the EU-funded INTERRFACE project.

Interoperable solutions will be key to overcoming technological barriers that currently hinder seamless data exchange between value chain actors and systems.

New platform helps derive value from digital technologies

Digitalisation facilitates the coordination and active system management in the electricity grid, enabling transmission and distribution network operators to optimise the use of distributed resources and ensure a cost-effective and reliable electricity flow.

INTERRFACE helps connect the dots between all parties across the entire electricity value chain through the design of an Interoperable pan-European Grid Services Architecture (IEGSA). Acting as an interface between transmission and distribution network operators, it introduces standardised ways of market operation, service design and procurement.

"The new platform for electrical grids and its interconnected tools and applications simplify market processes such as grid pre-qualification. They also reinforce the role of aggregators, who can transform the electricity business by lowering the entry barrier to the retail energy market, forging a firm link between consumers and the energy market and setting small players at a level playing field," adds Boultadakis.

Moreover, this refined service architecture integrates the main tools and data for network operators, power exchanges and market

participants, fosters communication between different data hubs and market applications, and ultimately facilitates energy market integration.

A glimpse into the inner platform components

The IEGSA platform comprises a set of components that smooth the day-to-day market operations. The flexibility register component gathers and shares relevant information on potential sources of flexibility, enabling the seamless connection of flexibility service providers and allowing them to bring their flexibility products to the markets. It collects static and dynamic characteristics of flexibility resources, creating accurate insight into the available flexibility potential, while also enabling efficient portfolio management for service providers.

The coordination platform fosters the collaboration between power system operators, allowing data exchange through well-defined, interoperable and standardised application programming interfaces that meet the Common Information Model standard. It also facilitates the bid qualification in various interconnected service markets.

Another component, the single interface to market, helps connect marketplaces with the platform, allowing the exchange of market-related data. Finally, the settlement unit is responsible for calculating the energy settlement.

INTERRFACE's platform has been deployed in nine countries. The demonstrators cover three thematic areas: congestion management and balancing, peer-to-peer trading and the pan-European electricity market.

"Overall, the achievements of the INTERRFACE project are paving the way towards integrating greater volumes of renewable energy to the electricity system without compromising security of supply, which is key to achieving carbon neutrality in the EU by 2050," Boultadakis concludes.

PROJECT
INTERRFACE – TSO-DSO-Consumer INTERFACE aRchitecture to provide innovative grid services for an efficient power system

COORDINATED BY
European Dynamics SA, Luxembourg

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/824330

PROJECT WEBSITE
interrface.eu/

Open access to the power grid shapes a more sustainable energy future

Future energy grids will be more open and participatory, becoming the entry point for new energy players. CoordiNet is taking the first steps towards a unified European electricity market platform that joins all parties across the entire electricity value chain – electricity carriers, distributors and consumers.

The energy landscape is changing rapidly. Centralised energy supply, which involves large-scale electricity generation at big, central power plants and unidirectional power flows, is grinding against the rise of smarter, cleaner technologies that offer new options to generate and manage energy locally. Renewable energies will become more mainstream parts of the electricity mix, and thus electricity generation will be more variable and decentralised, and less predictable.

Dissolving barriers to greater participation in the energy market

This new paradigm of electricity generation requires greater flexibility to match electricity supply and demand and ensure that the power system works safely and efficiently. Electricity carriers, distributors and consumers are called on to collaborate in defining their new roles in an environment where electricity no longer flows in one direction but bidirectionally. Digital technologies should also help reap the anticipated benefits stemming from smart grids as they guarantee appropriate levels of efficiency and interoperability, for example the ability of smart grid actors, components and applications to work together by exchanging data.

The EU-funded CoordiNet project aims to demonstrate how greater coordination between transmission system operators (TSOs) and the distributors, or DSOs, could help activate new grid services and create favourable conditions for all grid actors. TSOs are responsible for balancing electricity supply and demand between power stations and consumers and for managing transport grids (high voltage), while DSOs manage medium- and low-voltage grids. It also intends to break down the barriers that hinder participation in the energy market of customers and small market players connected to distribution networks.

Our purpose is to establish different collaboration schemes between power system operators and consumers to contribute to the development of a smart, secure and more resilient energy system.

"Our purpose is to establish different collaboration schemes between power system operators and consumers to contribute to the development of a smart, secure and more resilient energy system," notes project coordinator Marco Baron. The project is providing technical, regulatory and market solutions for system services securely and efficiently by using resources connected at different levels of the electricity grid. "Effective involvement of key stakeholders is crucial to making the necessary changes in the current electricity systems."

Pilot demonstrations

Power system operators and consumers have participated in three large-scale demonstration projects across 10 different locations in Greece, Spain and Sweden. The consortium defined standardised products that allow exchange of flexible services in the electricity system and the requirements that a unified European energy platform should meet.

"By testing a set of standardised products, CoordiNet should help determine mechanisms for providing the needed grid services at a distribution and a transmission level. These services include the reserve, activation and settlement processes," explains Baron. The project also explores game-changing technologies such as the Internet of things, AI, big data, peer-to-peer energy trading platforms and blockchain to facilitate market participation of small-scale energy prosumers.

The solutions tested in CoordiNet will pave the way for the interoperable development of a pan-European market that should allow all market participants to provide energy services and will open up new revenue streams for consumers providing grid services.

"Overall, we are developing cost-efficient models for electricity system services that can be scaled up to include networks operated by other transmission and distribution system operators and that will be replicable across the EU energy system. These should lay the foundations for new network codes, particularly on electricity balancing," Baron concludes.

PROJECT
CoordiNet - Large scale campaigns to demonstrate how TSO-DSO shall act in a coordinated manner to procure grid services in the most reliable and efficient way

COORDINATED BY
EDISTRIBUCIÓN Redes Digitales SL, Spain

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/824414

PROJECT WEBSITE
coordinet-project.eu/

Making people-centred smart cities a reality: the power of sharing data

Carefully designed, integrated, open-source solutions can be developed to improve the well-being of citizens as well as the sustainability of cities.

© Sharing Cities

Today, approximately 75 % of Europeans live in urban areas, a rate that is forecasted to increase in the future. With rapid urbanisation come several issues, including: pollution, health concerns and environmental degradation. Finding solutions to these problems is pivotal to helping Europe shift to a green, smart and sustainable future and to achieving the EU's ambition of climate neutrality by 2050.

Helping cities address some of the most pressing urban challenges today, the EU-funded Sharing Cities project is empowering cities to explore and exploit the potential of smart technologies to improve city services, support innovative new business models and deliver a better quality of life for all. "Since 2016, London, Lisbon, Milan, Bordeaux, Burgas and Warsaw collaborated to develop workable business models for smart technologies that can be scaled up and replicated across other European cities. In doing so, they have supported the growth of a new green smart infrastructure market," explains Jem McKenna-Percy, the partnership's lead.

Viable smart solutions

"Ten technologies were tested by the cities based around common needs, placing people at the centre of technological solutions," outlines McKenna-Percy. Known as the lighthouse cities, London, Lisbon and Milan have implemented replicable urban digital solutions and collaborative models. Fellow cities Bordeaux, Burgas and Warsaw have been working with the lighthouse cities to replicate the solutions.

One such solution is the Urban Sharing Platform (USP). Integrating a range of data from sources like smart lampposts and e-mobility sharing services, it collects and processes raw data to produce 'smart data'. This data can provide cities with invaluable insights to improve decision-making and deliver improved services. For instance, the Digital Social Market (DSM) in Lisbon – a mobile app – collects data around energy usage and provides users with information relevant to them. "The aim is to shift perceptions and change and promote sustainable behaviours," adds McKenna-Percy.

Another technological solution tested on the project was smart lampposts. In addition to providing light, they also include applications such as WiFi, parking sensors, video cameras and electric vehicle charging. In Milan, some lampposts have been equipped with environmental devices to help monitor flows of information such as noise level, air quality and traffic levels. "The information gathered will help to improve the lives of citizens," highlights McKenna-Percy.

Sustainable Energy Management Systems (SEMS) were also tested. A SEMS is a modular system that collects information from various local energy systems and devices, and can, for example, help provide information about energy demand

All six cities have demonstrated the benefits that using smart technologies and working together can have on carbon reductions, service delivery and well-being.

from a heating system. In London, the SEMS performs predictive forecasting and energy balancing for new energy assets. From the data collected, the system can optimise performance based desirable outcomes like operating costs and highest air quality.

Other key results can be found on each city profile on the project's website.

Sustainable cities for all

"All six cities have demonstrated the benefits that using smart technologies, sharing data and working together can have on carbon reductions, service delivery and well-being," highlights McKenna-Percy. The process of moving from pilot to scale-up has been captured and published in a series of six playbooks available for other European cities to adopt.

"We will continue to take significant steps to engage with other peer cities, so that many more communities across Europe and beyond can experience the benefits that smart technology brings to city life," concludes McKenna-Percy. Although the project has come to an end, participating cities continue to scale up some of the tested solutions.

PROJECT
Sharing Cities

COORDINATED BY
Greater London Authority, United Kingdom

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/691895

PROJECT WEBSITE
sharingcities.eu/

Seamlessly integrating energy devices and systems into smart homes, buildings and grids

As digital technologies transform the energy sector, users can more easily manage and control their appliances and systems. However, there are many solutions and standards to choose from, and not all of these can be combined and work together seamlessly. This complicates consumers' lives, and it is a barrier to a more rapid uptake of smart appliances and services.

Digitalisation of the energy sector has resulted in favourable regulatory conditions and technological innovations that are opening up new markets for services. As a result, the sector is becoming more user-centric and market-driven. A major challenge is connecting smart homes, buildings and electric grids in a trouble-free way. For a better-functioning, smarter, more integrated and cleaner energy sector, the future needs to be interoperable.

© metamorworks, Shutterstock

The EU-funded InterConnect project is developing solutions that address this challenge by means of an ontology-based semantic interoperability framework. It brings together 50 European partners from 11 countries, covering the entire energy value chain including manufacturers, providers and users, to develop and demonstrate advanced solutions for connecting and converging digital homes and buildings with the electricity sector.

A Smart Applications REFerence (SAREF) ontology contributes to the development of the global digital market by enabling solutions from different providers and activity sectors in the Internet of things (IoT) to work together. This includes domains such as big data, cybersecurity, electric grids.

Interoperable solutions for effective energy management

The solutions will enable the seamless connection of appliances and services based on indisputable semantic concepts (SAREF-ized services) rather than traditional application programming interface standards. This will accelerate the digitalisation of homes, buildings and electric grids based on a reference architecture for secure interoperable IoT smart home/building and smart energy systems.

Due to run until 2023, InterConnect will ensure interoperability between equipment, systems and privacy/cybersecurity of user data. This will be achieved by incorporating digital technologies such as AI, blockchain, cloud and big data based on open standards.

Testing for the solutions is under way in seven large-scale pilots in Belgium, Germany, Greece, France, Italy, the Netherlands and Portugal. These pilots are showcasing an effective digital market for reducing operational and investment costs that will benefit energy end users while helping the EU to meet its energy efficiency targets.

The project has set up and launched an online community of interoperable solutions that connect smart homes, buildings and grids. This platform is designed for a broad range of stakeholders all over the world who want to network, mentor, and exchange ideas on the digitalisation of homes, buildings and electric grids.

To grow the community of key players, InterConnect will also foster innovation by offering opportunities for entrepreneurs through open calls. In May 2022 and early 2023, two open calls will be launched to select the most innovative bottom-up projects by SMEs and start-ups. The calls aim to develop and test novel interoperable applications or services for smart homes and grids. An expression of interest for associated pilots that wish to join the InterConnect network of pilots will be launched in June 2022.

PROJECT
InterConnect – Interoperable Solutions Connecting Smart Homes, Buildings and Grids

COORDINATED BY
INESC TEC – Institute for Systems and Computer Engineering, Technology and Science, Portugal

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/857237

PROJECT WEBSITE
interconnectproject.eu/

Empowering consumers to become active stakeholders in the electricity ecosystem

An EU-funded project offers an intelligent solution to help increase the overall energy demand flexibility of residential and tertiary buildings.

Using different incentives, demand response (DR) programmes can help consumers reduce their energy usage during supply constraints or peak periods, giving them an opportunity to play an active role in the energy market.

In the EU, however, the take up of DR programmes has been slow, primarily because residential and tertiary buildings, responsible for 44 % of final energy consumption, are disconnected from DR activities as they do not participate directly in the wholesale

market. This is in contrast to industrial buildings or facilities that have the capability to manipulate their load capacity. This disconnection is due to technological and customer-related roadblocks.

On the technological side, there is a lot of fragmentation of protocols, data models and standards for building energy management systems and grid communications. On the customer side, risk aversion and the potential benefits are not well known and DR programmes can be intrusive, inconvenient and carry a risk of increased bills.

"As a result, the European energy system is currently missing out on a huge source of demand flexibility and the benefits that come with it," says Dimos Ioannidis, project coordinator of the EU-funded DRIMPAC project.

Unleashing the demand flexibility potential

With the aim of enabling the participation of small energy consumers in explicit and implicit DR programmes, the DRIMPAC team has developed a solution: a unified DR interoperability framework that enhances building management intelligence. The framework enables closer ties amongst the three main stakeholders of the electricity market.

"It will provide better and reliable communication among the distribution system operator (DSO), aggregator and the end user, with the latter being either a pure consumer, producer or a mix of both, i.e. a prosumer. This will allow the solution to be scalable and replicable," explains Ioannidis.

It is expected that the closer relationship between these stakeholders will give prosumers the opportunity to utilise their assets, such as any generation unit, and modify their consumption. "This lifts the end user from the status of a passive consumer to an active and vital stakeholder in the energy market," notes Dimitrios Tzovaras, DRIMPAC business innovation manager.

To make it easier for the end user to modify their assets as well as provide a human-centric approach that enhances the solution, hardware solutions will be placed within the end user's premises, with their consent, along with a user-friendly user interface environment.

It will provide better and reliable communication among the distribution system operator (DSO), aggregator and the end user, with the latter being either a pure consumer, producer or a mix of both.

Changing the building sector

The DRIMPAC technological framework and business models are being validated by four retailers supplying three energy carriers, specifically electricity, natural gas and district heating in Germany, Spain, France and Cyprus. Pilot demonstrations are taking place in a range of building types, including residential, office, educational and others, to validate the DRIMPAC benefits across most building typologies.

"Both implicit and explicit DR schemes are being examined, using dynamic DR tariffs schemes, such as time-of-use, critical peak pricing, real-time pricing and combinations of them in all four pilots, in order to come up with a sustainable business model," notes Paschalis Gkaidatzis, DRIMPAC project manager.

The project's validation activities are currently ongoing. "We expect our solution will result in a 20 % reduction in energy cost savings and 15 % in energy consumption as well as a 15 % peak load reduction," reports Ioannidis. This is centred on some initial objectives, based on preliminary validation activities conducted in a limited manner (e.g. small number of users, controlled in-door environment).

"In the long term, the project's solution can contribute to stable energy prices in Europe and the environmentally friendly generation of electricity," concludes Ioannidis.

PROJECT
DRIMPAC – Unified DR interoperability framework enabling market participation of active energy consumers

COORDINATED BY
Centre for Research & Technology Hellas, Greece

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/768559

PROJECT WEBSITE
drimpac-h2020.eu/

Tech tools bringing citizens and communities together for cleaner energy

Energy communities and other forms of energy-related citizens' organisations encourage consumers to have a direct stake in producing, using or sharing energy. An EU-funded project is creating a toolset to maximise the potential of these communities in Europe and beyond.

© COMPILE

By supporting social engagement and citizen participation, communities will play a key role in providing secure, affordable and clean energy. However, many more of such communities are needed as Europe transitions to green energy.

"We are using the power of the community to show the opportunities areas such as remote villages and small cities have in decarbonising energy supply, fostering community building, and creating environmental and socio-economic benefits fairly and cooperatively," explains Andrej Gubina from the Laboratory of Energy Policy at the University of Ljubljana in Slovenia, responsible for coordinating the COMPILE project.

"By introducing social elements in renewable energy transition, we enable the participation of every person who would like to invest in it, or just be a part of it."

Joining forces to decarbonise energy supply

The project has developed several technical tools to help operate and manage energy communities and other forms of energy-related citizens' organisations. HomeRule is a building energy management system application that regulates a single building or home's photovoltaic (PV) panel output to keep voltage levels within safe operating limits. This functionality is crucial in congested networks that frequently exceed voltage capacity. It is also important for installing additional PV panels without jeopardising the grid's operation in cases where distribution system operators limit or do not permit more panels. The tool informs users about consumption, production and stored energy.

GridRule assists those who operate, control or manage a local grid within network limits while improving flexibility, stability and security.

ComPilot is a digital platform that helps network operators and community managers to know more about how their community is performing and to better monitor and manage cooperation agreements in a user-friendly way. It also shows which areas could be improved and further developed. A major advantage of all the tools is that they can be replicated.

COMPILE is empowering and connecting people to take on their local energy systems with large or even entire shares of renewable energy.

Increasing energy independence across Europe

The tools are being tested at five pilot sites and are helping to address a broad range of issues.

Luče in Slovenia has a weak connection to the grid that results in frequent power outages. Actions such as installing new PV panels will help this remote village become the country's first community that is self-sufficient with energy. Installing a PV panel on the roof of a condominium with 150 apartments in Lisbon will cover the owners' energy needs for common building areas, including lighting, lifts and heating, ventilation and air conditioning systems. Consuming the energy amongst themselves and selling the surplus to the grid will ultimately contribute to creating the first collective community in Portugal that can self-supply energy.

The Greek port town of Rafina is benefiting from a new energy law. The law enables the creation of energy communities and other forms of energy-related citizens' organisations, and provides the legal framework with which to do so. These communities will alleviate energy poverty – the inability to maintain adequate levels of energy services at an affordable cost. Through crowdfunding, consumers have invested in a PV system installed on the roof of a technology park in Križevci, Croatia. Finally, in Crevillent, Spain, one of the oldest and largest energy cooperatives in the EU, local citizens are investing in renewable energy sources.

When fully developed and validated, the suite of tools will be commercialised. The project has already established connections with China and India as potential markets.

"COMPILE is empowering and connecting people to take on their local energy systems with large or even entire shares of renewable energy," concludes Gubina. "Our mission is to help as many community leaders and entire communities in the EU as possible."

More energy communities and other forms of energy-related citizens' organisations will certainly help put Europe on course to becoming the first climate-neutral continent by 2050.

PROJECT
COMPILE – Integrating community power in energy islands

COORDINATED BY
The University of Ljubljana, Slovenia

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/824424

PROJECT WEBSITE
compile-project.eu/

Digitalisation and data analytics support offshore wind farm deployment

Thanks to EU-funded innovation, offshore wind turbines are harnessing big data, machine learning, cloud computing and edge devices to streamline operations and maintenance and slash costs, enhancing deployment.

Offshore wind technologies will be key to Europe's green energy transition that includes important goals for integrating renewable energy sources and reducing CO_2 emissions.

The EU has targeted an increase in offshore wind capacity from its current level of 12 gigawatts (GW) to at least 60 GW by 2030 and to 300 GW by 2050. The massive deployment

of offshore renewable energy will help the EU meet its goal of climate neutrality by 2050 and foster economic growth and job creation in all parts of the renewable energy supply chain.

According to the International Energy Agency, the most critical areas for improvement to encourage rapid deployment of offshore wind capacity are technology improvement and cost reductions. The EU-funded ROMEO project has delivered a decision support system to reduce operations and maintenance (O&M) costs, leveraging condition monitoring, big data, machine learning and cloud-based analytics.

Comprehensive modelling supports advanced decision support

Structural health monitoring of wind energy systems is not a new idea. However, according to César Yanes of Iberdrola Renewable Energy and ROMEO coordinator, prior to ROMEO, much of the information and value in data coming from condition monitoring systems (CMSs) was not extracted. Optimising the way data is collected and analysed relies strongly on underlying models that accurately describe and predict behaviours as well as detect abnormalities, and models are a key project outcome.

Failure mode effect and criticality analyses were developed at project start to provide insight into critical failures to be assessed based on cost, frequency, or structural health and safety issues. Scientists developed physical and machine learning models for main turbine components (gearbox, main bearing, blade bearing generator, transformer and converter) to enable early fault detection, diagnosis and prognosis. Structural models will also support fatigue assessment and damage detection for wind turbine foundations.

Despite the required high level of confidentiality, the collaboration in ROMEO led to the delivery of models, analytical functionalities and case scenarios beyond those originally foreseen. The models enable failure detection in advance, and the analytical functionalities help O&M operators make better decisions, reducing costs. Some models have already been extrapolated to onshore wind farms, work that will continue in the coming months.

From the edge to the cloud and back to decision-makers

ROMEO developed a comprehensive data infrastructure to integrate the diverse sources of operational data from three pilot wind farms: Wikinger in Germany, and Teesside and East Anglia ONE in the United Kingdom.

"Our data infrastructure ensures compatibility with the models that interpret the data, connecting the wind farms' supervisory control and data acquisition systems, CMSs and other data sources – including a newly deployed edge device with processing capabilities – to IBM's cloud. The models, running in the cloud environment, feed their results to an intuitive information management platform to improve decision-making," explains Yanes.

© Iberdrola

Our data infrastructure ensures compatibility with the models that interpret the data, connecting the wind farms' supervisory control and data acquisition systems, CMSs and other data sources ... to IBM's cloud.

ROMEO has harnessed big data, machine learning, cloud computing and edge devices in a next-generation CMS complete with an intuitive information management platform. The holistic technologies and analytical tools will support the transition from calendar-based and corrective maintenance to condition-based maintenance while simultaneously reducing the number of unexpected major failures and ensuring better logistics planning.

Preliminary results suggest significant reductions in O&M costs that should spur deployment while leading to reductions in the cost of wind energy for customers.

PROJECT
ROMEO - Reliable OM decision tools and strategies for high LCoE reduction on Offshore wind

COORDINATED BY
Iberdrola Renewable Energy, Spain

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/745625

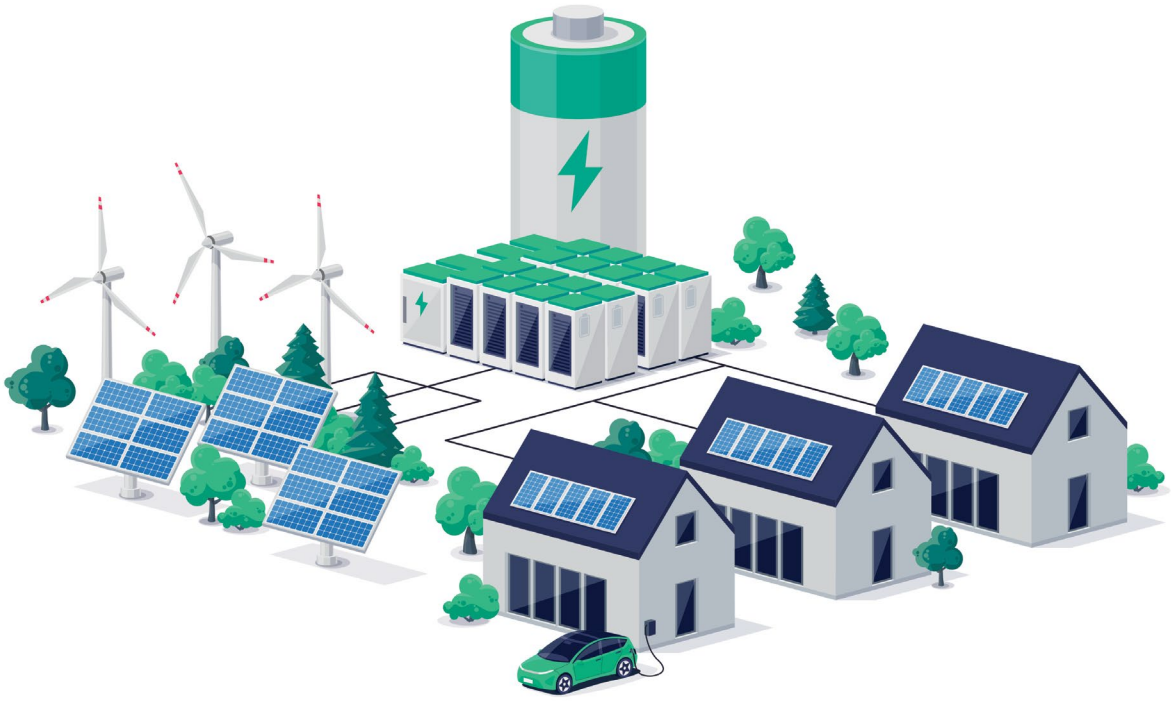
PROJECT WEBSITE
romeoproject.eu/

Better managing fluctuating supply and demand creates a starring role for renewables

An advanced energy 'aggregator' that flexibly creates virtual power plants from distributed energy resources and storage systems on fast and slow timescales paves the way to an energy system based entirely on renewables.

The global energy infrastructure landscape is rapidly evolving, from primarily large-scale centralised generation and distribution to a mix including small- and medium-scale distributed energy resources (DERs) and energy storage systems. These have a growing contribution of intermittent renewable energy sources (RESs).

With this complexity comes flexibility for mix-and-match opportunities depending on real-time supply and demand. Leveraging this can be accomplished with virtual power plants (VPPs). The EU-funded EdgeFLEX project is expanding the current VPP model with a VPP system integrating multiple layers of control that paves the way to a fully renewable energy system.



Large-scale networks integrating local hubs

Homes and communities are increasingly producing and storing energy locally. From consumers, they have evolved into prosumers – both producers and consumers. Additionally, demand-side management has appeared, using incentives that encourage customers to change their energy consumption patterns.

VPPs have been around for about two decades, networking and optimising DERs including those employing RESs, balancing the variable generation and flexible demand. EdgeFLEX is enhancing their operation with its novel multilayer VPP architecture that integrates frequency and inertial response control concepts with dynamic-phasor -driven voltage control and leverages 5G communications.

The platform will support local energy communities and other forms of energy-related citizens' organisations with enhanced demand-side management in which 5G-powered edge clouds link dispersed devices in near real time. It will also enable VPPs to interact with markets offering ancillary services that help grid operators maintain a reliable electricity system.

Optimising fast edge-type services and slow intraday market dynamics

EdgeFLEX has developed hardware and software solutions supporting its VPP platform, including edge-connected units for monitoring and control of fast dynamics; a novel 5G application programming interface for edge-connected device management; and the FlexOffer protocol facilitating automated flexibility trading for prosumers and other actors throughout the day. The project is complementing the theoretical and modelling outcomes with three field trials and laboratory tests.

The consortium is also actively contributing to standards and European-level regulations that reduce barriers to uptake. For example, its edgePMU device that improves grid observability has been included in the standards of the 3rd Generation Partnership Project, or 3GPP, uniting seven telecommunications standards development organisations for 3G and beyond. EdgeFLEX is also exploring financial tools and business scenarios to simplify investments in RESs beyond subsidy schemes.

Now in its final year and with 21 peer-reviewed articles to date, the team is preparing to summarise pilot and lab results. EdgeFLEX and its multilayer VPP platform and technologies could soon be supporting edge-connected monitoring devices, local communities and flexibility markets on the road to a fully renewable, dynamically adaptive and stabilised energy system.

PROJECT
EdgeFLEX – Providing flexibility to the grid by enabling VPPs to offer both fast and slow dynamics control services

COORDINATED BY
Ericsson GmbH, Germany

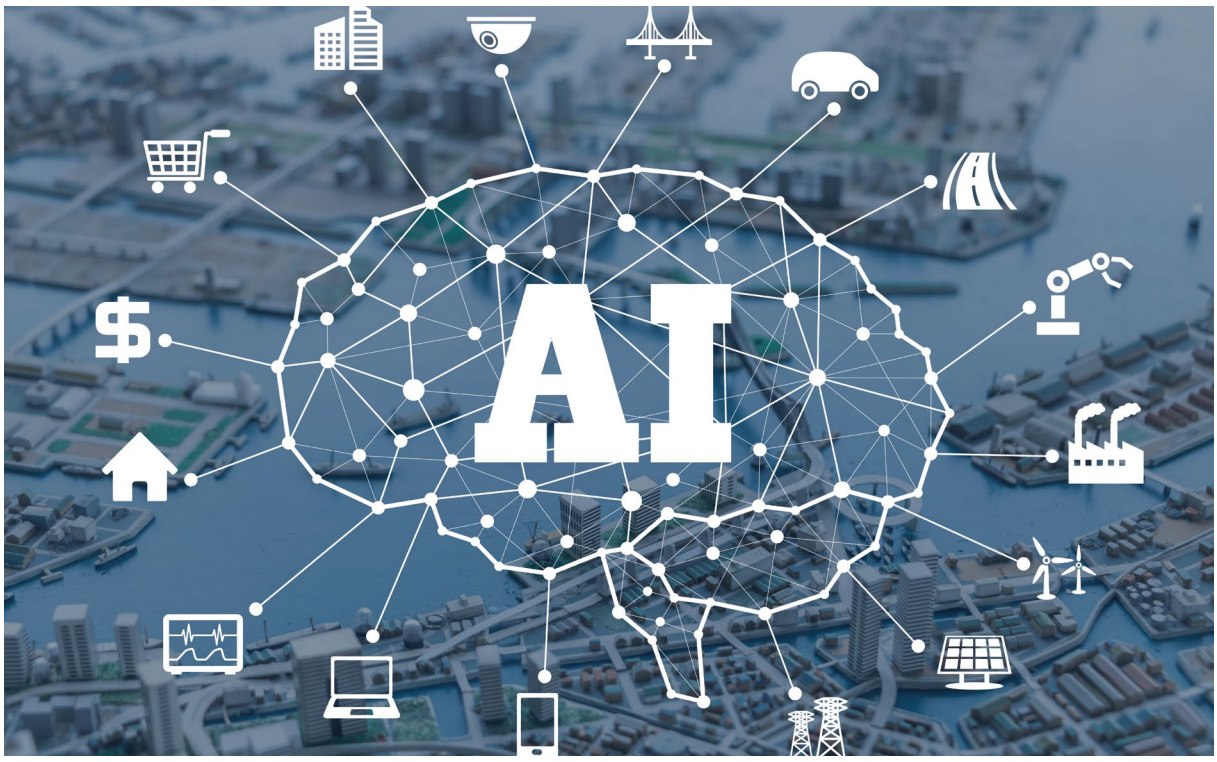
FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/883710

PROJECT WEBSITE
edgeflex-h2020.eu/

Getting more 'intelligent' about internet security

Cognitive packets of internet information could revolutionise cybersecurity. Rerouting themselves dynamically and with great agility, they can avoid security threats or breaches in the network.



Most of us are highly aware of the need to protect our personal data on the internet – our email accounts, bank accounts, health information and so much more. As we rapidly move to the Internet of things (IoT), the 'things' requiring protection range from home ovens to sophisticated industrial tools, self-driving cars and remotely operated surgical equipment. Underlying these and more, including military communications and defence, is the electric power grid.

Current internet protection is primarily static, detecting and blocking portions of an IoT system under attack but not rerouting information intelligently and avoiding glitches or worse. The EU-funded SerIoT project has delivered an unprecedented adaptive and intelligent solution by the same name. It will ensure IoT networks safely continue business as usual regardless of network conditions.

Cognitive intelligence and self-awareness for IoT

IoT networks connect sensors and actuators related to a physical system like a factory, vehicle or smart grid with software

systems that control the system's functions. Conventional networks use hardware like routers and switches to direct network traffic. SerIoT relies on cognitive intelligent control based on random neural networks and implements the controls through software-defined networking (SDN).

SDN uses software-based technologies to control routers and direct network traffic in the form of internet packets, or blocks of information. This also enables flexible and dynamic configuration of 'virtual networks' from physical ones depending on needs at the time. SerIoT added to this flexibility by integrating AI into the packets themselves, creating a patented cognitive packet network (CPN).

Erol Gelenbe of the Institute of Theoretical and Applied Informatics, Polish Academy of Sciences and SerIoT coordinator explains: "SerIoT introduced self-awareness into SDN through a CPN in which the packets route themselves adaptively via SDN controllers with integrated AI. Attack and security detectors support rerouting of traffic to avoid items or areas that may be insecure due to threats or attacks."

SerIoT introduced self-awareness into SDN through a CPN in which the packets route themselves adaptively via SDN controllers with integrated AI. Attack and security detectors support rerouting of traffic to avoid items or areas that may be insecure due to threats or attacks.

Each cognitive packet is thus self-aware, adaptive and intelligent, reacting not only to security issues but also network congestion or changes in energy consumption to improve the IoT system's or network's performance. The background and description of the practical working system have been published.

A dynamic line of defence that goes where it is needed

Gelenbe summarises: "SerIoT not only allows the IoT system to operate normally while under attack, but even at such times it saves energy and optimises performance. It can be installed in existing SDN technology, allowing the approach to be ported to many unforeseen applications."

SerIoT moves the field of cybersecurity from the static mentality to an active, highly mobile, agile and adaptive system that not only defends against cyberattacks but moves critical traffic away from attack paths, adds Gelenbe.

The large-scale pilots, including with project partner Deutsche Telecom, targeted the smart grid, which uses the IoT extensively, exploiting smart meters to optimise electricity production and distribution. Smart vehicles and Industry 4.0 robots were also tested.

SerIoT is available for demonstration and beta testing by commercial partners and is being exploited in the ongoing Horizon 2020 IOTAC project. SerIoT will ensure that global IoT traffic agilely detours around malicious and natural obstacles large and small, for business as usual.

PROJECT
SerIoT – Secure and Safe Internet of Things

COORDINATED BY
The Institute of Theoretical and Applied Informatics, Poland

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/780139

PROJECT WEBSITE
seriot-project.eu/

New toolkit to protect energy grids against cybersecurity threats and attacks

New technologies and smart devices are exposing energy infrastructure vulnerabilities. The EnergyShield toolkit supports electrical power and energy system operators in the fight against sophisticated cyber and privacy attacks and data breaches.

© Lari Saukkonen, Shutterstock

Deliberate disruptions of electrical power and energy systems are a game-changer. In 2015 in Ukraine, using BlackEnergy, targeted spear phishing campaigns were launched against energy companies, where the attackers accessed power network companies, then learned the operations and used the legitimate functionality of distribution management systems to disconnect substations from the grid, leaving over 225 000 customers without power.

EnergyShield is tackling the energy sector cyberthreats by adapting and integrating technologies for vulnerability assessment, supervision and protection in a defensive toolkit.

"Electrical power and energy systems are most frequently targeted by cyberattacks like phishing, social engineering, whaling, distributed denial-of-service (DDoS) attacks, malware and ransomware. The threat continues to evolve as attackers try to access industrial control systems through third parties. Thus, greater efforts are needed to manage cybersecurity risks," says Otilia Bularca, project manager at Romania-based company Software Imagination & Vision SRL and coordinator of the EU-funded EnergyShield project.

"Scientific and technical communities work together to innovate, design and deploy technologies that are more resilient and protective. EnergyShield is tackling the energy sector cyberthreats by adapting and integrating technologies for vulnerability assessment, supervision and protection in a defensive toolkit," adds Bularca.

A set of different modules

The EnergyShield solution combines a broad set of tools that help increase resilience against different types and levels of cyber and privacy attacks and data breaches.

A security behaviour analysis tool evaluates the current security readiness of an organisation. It allows operators to identify entry points, the so-called human attack surface that largely results from lack of awareness or inappropriate access control.

A vulnerability assessment tool assesses the cybersecurity resilience through threat modelling and attack simulations. The tool collects the attacker's most likely path and plots the probability of the attacker reaching the asset.

The DDoS mitigation module actively defends the systems against incoming traffic flooding. The module leverages machine learning-based algorithms to detect and mitigate application-layer DDoS attacks on the communication infrastructure.

The anomaly detection module analyses the network traffic and points out unexpected events. It detects anomalies at the operational technology layer, protecting control infrastructure against man-in-the-middle or replay attacks.

Finally, a security information and event management tool enables critical infrastructure operators to share early warning on cybersecurity risks and incidents as well as to report major breaches on their core services.

All these tools are accommodated in a central federation coordinator with locally deployed federation members. The central component is responsible for maintaining the rules and standards and for common processing, while the federation members are responsible for local data collection and processing.

Technology demonstrators

The project outcomes will be demonstrated in two pilot sites to validate the innovative models, algorithms and cybersecurity solutions. In Bulgaria, a city-level online demonstrator is proposed to investigate the cascading effects of cyberattacks throughout the electrical power and energy system value chain and analyse cybersecurity risks related to the cyber supply chain. A smaller offline demonstrator is being prepared in Italy where a cyberattack on a network control subsystem will be simulated.

Project findings will serve as a proxy for developing best practices, guidelines and methodologies, encouraging widespread adoption of the project tools in the energy sector.

PROJECT
EnergyShield – Integrated Cybersecurity Solution for the Vulnerability Assessment, Monitoring and Protection of Critical Energy Infrastructures

COORDINATED BY
Software Imagination & Vision SRL (SIMAVI), Romania

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/832907

PROJECT WEBSITE
energy-shield.eu/

On the path to green, clean and economical data centres throughout Europe

Data centres' impact on the environment is a growing concern, especially since they use about 3 % of Europe's electricity. The BodenTypeDC project built a data centre to address the need for more energy efficiency.

Data centres have become critical infrastructure in today's world because they house vital assets such as networked computers, storage systems and equipment that keep all kinds of organisations running smoothly. "Despite their importance to the continuity of daily operations, data centres need to become more energy efficient, reuse waste energy such as heat and use more renewable energy sources, with a view to becoming closer to carbon neutral by 2030," explains Tor Björn Minde, Head of ICE Data center at RISE Research Institutes of Sweden.

© H1 Systems

Most data centres consume almost as much electricity in their cooling systems as in their servers. At a typical data centre, about 40 % of the electricity is consumed by cooling systems.

The EU-funded BodenTypeDC project constructed, tested and validated a data centre called Boden Type Data Center (BTDC) One that is both energy and cost efficient. It runs on renewable energy and relies on free air and evaporative cooling technologies without the need for refrigerants. It also uses low-carbon, locally sourced building materials.

Holistic approach to cooling

For data centres that use cool air, energy can be wasted by providing too much air to the IT space from the cooling equipment. Usually, air-cooled systems are controlled by providing a set temperature to the cold aisles. This consistently results in a slow response by the cooling systems to the thermal swings in the data centre that are created by large changes in the IT workload. In BTDC One, the cooling intelligently adapts to and works together with an algorithm that controls IT workloads, server fan speed and temperature in order to maximise efficiency.

The project team claims BTDC One is the world's most efficient data centre with minimal environmental impact. They have the effectiveness benchmark to back it up. Power usage effectiveness (PUE) is the industry standard metric (ISO) that describes how effective a data centre uses overhead energy over a period of one year. The lower the PUE, the greater the effectiveness, with 1.00 being the absolute highest level of effectiveness. The BTDC One has achieved a PUE of less than 1.02. Data centres in the EU have an average PUE above 1.5.

Location, location, location

Using highly innovative engineering principles, project partners built the sustainable, ultra-efficient, ultra-low-cost data centre in Boden, Sweden, close to the Arctic Circle. This location was a strategic move on their part.

Over the last few years, the Nordic countries have become the go-to market for data centres. They are widely considered amongst the best places in the world to set up data resources. The region's appeal isn't surprising given that data centre operators are increasingly seeking colder climates to reduce their dependence on power to cool their equipment. The abundance of renewable energy in the area is another factor that makes places like Boden more suitable for such facilities and very attractive for investment.

"The BTDC One solution offers a sustainable data centre building model that is energy and resource efficient throughout its life cycle. It's cheaper to build and operate," concludes Minde. "Ultimately, the goal is to replicate the design throughout Europe, even in countries with less favourable climatic conditions, and combine this design with waste heat reuse in less remote areas."

The BTDC One solution offers a sustainable data centre building model that is energy and resource efficient throughout its life cycle. It's cheaper to build and operate.

PROJECT
BodenTypeDC – Prototyping the most energy and cost efficient data center in the world: The Boden Type Data Center

COORDINATED BY
SYSTEMS MERNOKI SZOLGALTATASOK KORLATOLT FELELOSSEGU TARSASAG, Hungary

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/768875

PROJECT WEBSITE
bodentypedc.eu/

CORDIS Results Pack

Available online in 6 language versions: cordis.europa.eu/article/rcn/436700

Published
on behalf of the European Commission by CORDIS at the
Publications Office of the European Union
2, rue Mercier
2985 Luxembourg
LUXEMBOURG

cordis@publications.europa.eu

Editorial coordination
Birgit BEN YEDDER, Staffan VOWLES

This Results Pack is a collaboration between CORDIS and the European Climate, Infrastructure and Environment Executive Agency (CINEA).

Print	ISBN 978-92-78-42936-2	ISSN 2599-8285	doi:10.2830/024297	ZZ-AK-22-006-EN-C
HTML	ISBN 978-92-78-42935-5	ISSN 2599-8293	doi:10.2830/24431	ZZ-AK-22-006-EN-Q
PDF	ISBN 978-92-78-42934-8	ISSN 2599-8293	doi:10.2830/974948	ZZ-AK-22-006-EN-N

Luxembourg: Publications Office of the European Union, 2022

CINEA – Horizon project manager

Most of the projects featured in this Results Pack are managed by CINEA, the European Climate, Infrastructure and Environment Executive Agency, established by the European Commission under the motto 'Funding a Green Future for Europe'. CINEA contributes to the European Green Deal by implementing parts of EU funding programmes for transport, energy, climate action, environment and maritime fisheries and aquaculture. CINEA now manages the Connecting Europe Facility 2 (Transport and Energy), the Climate, Energy and Mobility Cluster of Horizon Europe, the LIFE programme, the Innovation Fund, the European Maritime, Fisheries and Aquaculture Fund, the Renewable Energy Financing Mechanism and the Public Sector Loan Facility under the Just Transition Mechanism and seeks to promote synergies between the programmes in order to benefit EU citizens and promote economic growth.

CINEA implements two societal challenges of the Horizon 2020 programme: Secure, clean and efficient energy, and Smart, green and integrated transport. CINEA provides technical and financial management services at all stages of the programme and project life cycle – from the calls for proposals, evaluation of projects and the award of financial support, to the follow-up of project implementation and control of the use of funds allocated.

CINEA provides visibility for EU funding opportunities and project results – and supports potential applicants and beneficiaries, allowing them to benefit from the Agency's long-standing experience of programme implementation with a high level of performance.

More details can be found on CINEA's website at: cinea.ec.europa.eu/index_en

Follow us on social media too!

@CINEA_EU
@CleanEnergy_EU

@CINEA

@CINEATube

RESULTS PACK ON PRIVATE FINANCE FOR ENERGY EFFICIENCY – SECOND EDITION

Making Europe more energy efficienct will play a key role in achieving carbon neutrality by 2050. This updated CORDIS Results Pack features groundbreaking research that can accelerate and upscale private financing of energy efficiency investments across the EU.

Check out the pack at
cordis.europa.eu/article/id/422225

Publications Office
of the European Union

Follow us on social media too!
facebook.com/EUresearchResults
twitter.com/CORDIS_EU
youtube.com/CORDISdotEU
instagram.com/cordis_eu

EN